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Computers Against Infectious Diseases: NIH Project Aims to Combat Bioterrorism

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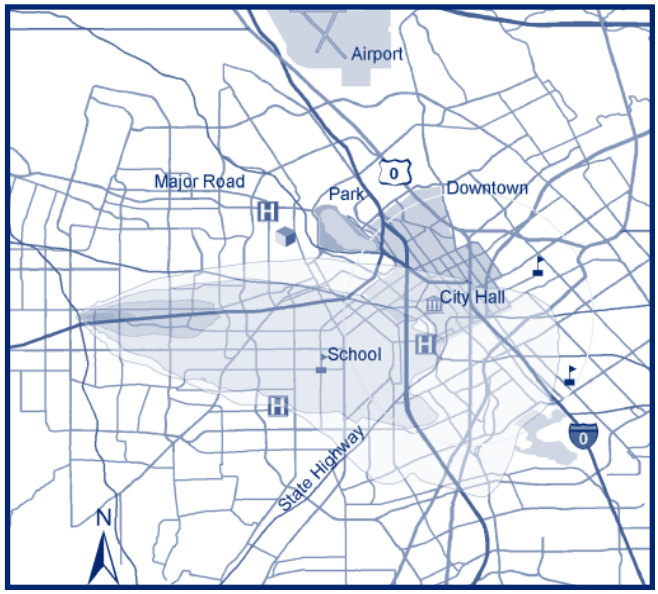
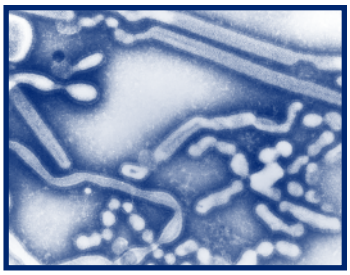
A new initiative from the National Institutes of Health (NIH) aims to harness the nation's computing skills to help prevent and respond to disease outbreaks, whether they occur naturally or as a result of bioterrorism. The initiative, called MIDAS, supports researchers from different disciplines—such as statistics, epidemiology, and public health—to develop user-friendly computer models of how epidemics arise and spread and what kind of responses work best to combat them. **MIDAS, an acronym for Models of Infectious Disease Agent Study**, is sponsored by the National Institute of General Medical Sciences (NIGMS), which awarded the first four grants for this project in May. The grants total more than $28 million over 5 years.

"MIDAS will play a key role in the NIH biodefense plan," said Elias A. Zerhouni, M.D., the NIH director. "The computer models created through this initiative will help us determine the best strategies to detect, control, and prevent the spread of disease."



Computer simulations like this, which models the release of sarin gas over a city, help scientists study the spread of chemical, biological, and radiological agents. MIDAS scientists will develop similar models to help understand and respond to the spread of infectious diseases. Credit: "National Atmospheric Release Advisory Center"

Except under unusual circumstances, the databases, analytical tools, and simulation models developed through the MIDAS initiative will be made available to the scientific community, policy makers, and public health officials. If there is an infectious disease outbreak, NIH may call upon the MIDAS network to develop specific models to help public officials understand and respond to the outbreak.



Electron micrograph of influenza A, which caused the 1918 flu pandemic and other major flu epidemics. It is the first disease MIDAS scientists will model together. Credit: CDC/Dr. Erskine Palmer

"MIDAS is designed not only to help prepare us for infectious disease crises, but also to be an active part of the response," said Jeremy M. Berg, Ph.D., the NIGMS director. "In the case of a national medical emergency, MIDAS scientists can redirect their work to help government officials quickly determine the best way to deal with the epidemic."

The network is guided by a steering committee, which consists of scientists involved in MIDAS research as well as NIH representatives and outside experts. The committee predicts that MIDAS will gain recognition and develop enhanced tools as it builds long-term relationships with other agencies and with the public health community.

In an effort to quickly develop resources and collaboration within MIDAS, the committee requested that, in addition to the individual projects being conducted by each group, the network immediately begin to study a problem together. The committee selected influenza, spreading after a slight genetic change, as the first disease to model. MIDAS researchers plan to take into account variables such as the structure of social networks, availability of transportation, and travel policies. They will also attempt to computationally replicate historical outbreaks, such as the 1918 flu pandemic, to validate and fine-tune their models.

The four MIDAS projects currently underway include one informatics group and three research groups:

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"NIH Project" cont.

• Pilot Projects for Models of Infectious Disease Agent Study (MIDAS)
Principal investigator: Diane Wagener, Ph.D., Research Triangle Institute International This informatics group is responsible for developing computational tools and data sets for the three research groups described below. This team will also create a portal that will allow access by the scientific community, policy makers, and medical personnel to MIDAS databases, analytical and statistical tools, and simulation models. Research Triangle Institute International is working with IBM to develop infrastructure for MIDAS, and with SAS Institute, Inc. to provide statistical tools for analyzing and verifying models. Consultants from Duke and Emory Universities are contributing expertise in infectious disease modeling and biological information analysis.

• Computational Models of Infectious Disease Threats
Principal investigator: Don Burke, M.D., the Johns Hopkins University
This diverse team will create highly visual, user-friendly models of disease outbreaks using historical and modern data. The models will incorporate factors such as length of disease incubation, transmission rate, weather patterns, the individual susceptibility of people, and social networks. The researchers—scientists from the Johns Hopkins University, the Brookings Institution, NASA, the University of Maryland, the University of Pittsburgh, and Imperial College London—will evaluate the efficacy of various containment strategies, such as vaccination, contact tracing, and quarantining. They plan to analyze outbreaks of smallpox, dengue fever, and West Nile virus. The collaborating investigators are experts in infectious diseases, epidemiology, ecology, biostatistics, time series analysis, non-linear dynamics, network theory, and decision theory.

• Population Mobility Models of Urban Disease Outbreak
Principal investigator: Stephen Eubank, Ph.D., Los Alamos National Laboratory
This research group will explore the effects of social networks in hypothetical urban areas (population 1.5 million) on the spread and possible containment of multiple, interacting disease-causing organisms. The scientists will model how social contacts might change in response to an outbreak or to intervention strategies. The basis for these models will be a program (EpiSims) originally designed to study transportation networks. The researchers will model how social contacts might change in response to an outbreak or in response to intervention strategies. The models will incorporate variables such as the transmission dynamics of various diseases, modes of pathogen introduction into communities, the initial state of health of a population, and response strategies. The researchers will attempt to parse out which features of social networks have the most effect on the course of a potential epidemic. The scientists will also modify the social networks and populations to simulate epidemics in a variety of hypothetical cities.

• Containing Bioterrorist and Emerging Infectious Diseases
Principal investigator: Ira Longini, Ph.D., Emory University
This research group will model a disease outbreak in hypothetical American communities (population sizes 2,000 to 48,000) to find the best method(s) of controlling the epidemic. The researchers will examine the effectiveness of policies including surveillance and containment, vaccination, medical treatment and the closing of key institutions. They will adapt their model for smallpox, SARS, pandemic influenza, and other possible bioterrorism agents or naturally occurring diseases. They will also investigate how certain microorganisms cause disease within individual people and then spread through a population.

More information and resources are available at the MIDAS Web site: http://www.nigms.nih.gov/research/midas.html. The site includes a PowerPoint presentation describing the organization and goals of MIDAS, project summaries from the funded research groups, and meeting reports.